REMARKS

By this amendment, claims 1-4, 6-14, 23-30, 33-42, 44-51, and 57-63 are pending in the application, of which claims 1, 23, 30, 38, 44, 57, and 60 are being amended and claims 61-63 are being added. Claim 34 is being canceled, without prejudice or disclaimer, because of overlapping subject matter with amended claim 30, from which it is dependent. Reconsideration of the present case in view of the amendments and remarks herein is respectfully requested.

The amendments to the claims are supported by the original Specification and claims as filed, and add no new subject matter. Amended claims 1 and 38 are supported, for example, at page 14, line 25, to page 16, line 17, of the Specification. Amended claim 30 is supported at page 9, lines 25 to 31.

Finality of Office Action

The Examiner improperly made the last Office Action final. Applicant's last amendment did not necessitate the new references because all of the newly cited references (Piwonka-Corle and Cates et al.) are being relied on by the Examiner to read on language in the claim amendments that was already present or implied in the claims before the amendment. For example, the "mathematically operate" language amended into claims 1 and 30 was originally implicitly present in claim 23 in the language "determining a corrected sample signal, X_{nt}, using the expression $X_{nt} = X_t/\{Y_0 + C(Y_t - Y_0)\}$" before the amendment. This expression is a mathematical expression that includes operations on the variables in the expression. Therefore, to use this mathematical expression is to "mathematically operate." In another example, the "signal analyzer adapted to normalize the sample signal relative to the reference signal" language amended into claims 30 and 38 was originally presented in claim 1. Thus, the finality of the last Office Action is believed to be improper.

103(a) Rejection of Claims 1-4, 11-14, 30, 33-35, and 37-39

The Examin r rejected claims 1-4, 11-14, 30, 33-35, and 37-39 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,002,631 to Giapis et al. in view of U.S. Patent 5,608,526 to Piwonka-Corle (Piwonka-Corle). This rejection is respectfully traversed.

Claim 1

Claim 1, as amended, recites a substrate etching apparatus comprising, inter alia, "(b) one or more detectors to (i) detect an intensity of a first radiation originating from the radiation source and reflected from the substrate or a chamber wall and generate a sample signal, and (ii) detect an intensity of a second radiation emitted from the radiation source and generate a reference signal; and (c) a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) a fluctuation in the reflected radiation that originates from the radiation source and (ii) background radiation that is not from the radiation source."

The Examiner acknowledges that Giapis et al. does not teach "a signal analyzer adapted to normalize the sample signal relative to the reference signal by mathematically operating ..." The Examiner then relies on Piwonka-Corle to make up for this deficiency.

However, Piwonka-Corle also fails to teach "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) a fluctuation in the reflected radiation that originates from the radiation source and (ii) background radiation that is not from the radiation source."

Instead, Piwonka-Corle teaches an ellipsometer to determine a thickness or refractive index of a sample (3). Radiation from a lamp (10) is split into a sample beam (9) and a reference beam (109). The sample beam (9) is refl cted from the

sample surface, whereas the reference beam does not reflect from the sample, but is directed directly to a spectrometer to "compensate for such effects as lamp intensity fluctuations and air currents" in the vicinity of the lamp. These lamp intensity fluctuations and air currents are fluctuations in the reflected radiation <u>from the radiation source</u>.

Piwonka-Corle does not recognize the problem of undesirable contributions of "background radiation that is not from the radiation source," as solved by the signal analyzer of claim 1. For example, Piwonka-Corle does not recognize the problem of ambient radiation from a plasma in the chamber. Instead, Piwonka-Corle only recognizes the problem of variations from the radiation source: "<u>If such effects are time varying</u> (during the time scale of a single sample measurement) they can affect the measurement..." (Emphasis added.) The problem of background radiation that is not from the radiation source is discussed and solved in the instant application. (Page 14, line 25 to page 16, line 17.)

Thus, claim 1 and the claims dependent therefrom, including claims 2-4 and 11-14, are allowable over Giapis et al. in view of Piwonka-Corle.

<u>Claim 30</u>

Giapis et al. does not teach "one or more first fibers to transmit the reference radiation from the radiation source to the reference detector and one or more second fibers to transmit radiation from the radiation source to the chamber, the first and second fibers arranged to individually receive radiation from the same spatial area of the radiation source."

Piwonka-Corle does not make up for the deficiencies of Giapis et al. Instead, Piwonka-Corle teaches a single fiber (1) into which illuminating radiation from a lamp (10) enters, as shown in Figure 12. This is not the same as first <u>and</u> second fibers <u>arranged to individually receive</u> radiation <u>from the same spatial area</u> of the radiation source. Arranging the first and second fibers to individually receive radiation from the

same spatial area allows the same source fluctuations to be seen, as discussed in the instant application. (Page 10, line 14 to line 21.)

Thus, claim 30 and the claims dependent therefrom, including claims 33-35 and 37, are allowable over Giapis et al. in view of Piwonka-Corle.

<u>Claim 38</u>

The Examiner acknowledges that Giapis et al. does not teach "a signal analyzer adapted to normalize the sample signal relative to the reference signal by mathematically operating ..."

Piwonka-Corle also fails to teach "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) the background radiation from the plasma and (ii) a fluctuation in the reflected radiation."

Instead, Piwonka-Corle teaches a processor that can "compensate for such effects as lamp intensity fluctuations and air currents" in the vicinity of the lamp. These lamp intensity fluctuations and air currents are fluctuations in the reflected radiation <u>from the radiation source</u>. Piwonka-Corle fails to recognize the problem of an undesirable contribution of "background radiation from the plasma," as solved by the signal analyzer of claim 38.

Thus, claim 38 and the claims dependent therefrom, including claim 39, are allowable over Giapis et al. in view of Piwonka-Corle.

103(a) R jection of Claims 6-10 and 23-29

Th Examiner rejected claims 6-10 and 23-29 under 35 U.S.C. 103(a) as being unpatentable over Giapis et al. and Piwonka-Corle, in view of U.S. Patent 6,328,517 to Cates et al. This rejection is respectfully traversed.

Claim 1

Claims 6-10 are allowable over Giapis et al. and Piwonka-Corle because they are dependent on claim 1, which is allowable over Giapis et al. and Piwonka-Corle for the reasons presented above.

Cates et al. fails to make up for the deficiencies of Giapis et al. and Piwonka-Corle because Cates et al. also does not teach "a signal analyzer to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) a fluctuation in the reflected radiation that originates from the radiation source and (ii) background radiation that is not from the radiation source."

Instead, Cates et al. teaches that a processor may divide a signal by "a corresponding normalization signal obtained from a sample optical energy (18') of the light from [the optical energy] source (14)." (Col. 15, lines 61-65.) Outputs are normalized "for variations in the intensity of the output of optical energy source." (Col. 17, line 64 to col. 18, line 2.) However, Cates et al. is silent on the matter of compensating for "background radiation that is not from the radiation source."

Thus, claim 1 and the claims dependent therefrom, including claims 6-10, are allowable over Giapis et al. and Piwonka-Corle, in view of Cates et al.

Claim 23

The Examiner acknowledges that Giapis et al. and Piwonka-Corle "do not teach a signal analyzer that performs the normalization by assigning a specific mathematical algorithm for the normalization."

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Cates et al. fails to make up for the deficiencies of Giapis et al. and Piwonka-Corle because Cates does not teach, inter alia, "a signal analyzer to receive the sample signal and determine a corrected sample signal, X_{nt}, using the expression $X_{nt} = X_t / \{Y_0 + C(Y_t - Y_0)\}$, where C is a correction factor, Y_0 is a reference signal at time 0, X_t is the sample signal at time t, and Y_t is the reference signal at time t."

Instead, Cates et al. teaches a processor to determine simple quotients of the form described in column 18, lines 32-44, such as "Signal116i/Signal166." A processor that uses this mathematical form is different from a signal analyzer that uses the mathematical expression $X_{nt} = X_t / \{Y_0 + C(Y_t - Y_0)\}$ to determine a corrected sample signal. The "Signal116i" term in Cates roughly corresponds to the X_t term in claim 23, and the "Signal166" term in Cates roughly corresponds to the Y_t term in claim 23. The quotients are different because, for example, the denominator of X_{nt} in claim 23 contains other terms that allow improved correction of the sample signal: the correction factor C and the reference signal Y_0 at time 0. Using the mathematical expression $X_{nt} = X_t / \{Y_0 + C(Y_t - Y_0)\}$ permits the signal analyzer to correct for background radiation in addition to radiation source fluctuations in the sample signal. For example, the signal analyzer can use this mathematical expression to correct for ambient contributions from the plasma to the sample signal.

Thus, claim 23 and the claims dependent therefrom, including claims 24-29, are allowable over Giapis et al. and Piwonka-Corle, in view of Cates et al.

103(a) R jection of Claim 36

The Examiner rejected claim 36 und r 35 U.S.C. 103(a) a b ing unpatentable over Giapis et al. and Piwonka-Corle, in view of Japanese Patent 01260304 to Taketora Saka. This rejection is respectfully traversed.

Claim 30

Claim 36 is allowable over Giapis et al. and Piwonka-Corle because it is dependent on claim 30, which is allowable over Giapis et al. and Piwonka-Corle for the reasons presented above.

Saka does not make up for the deficiencies of Giapis et al. and Piwonka-Corle because Saka also fails to teach a substrate etching apparatus comprising, inter alia, "one or more first fibers to transmit the reference radiation from the radiation source to the reference detector and one or more second fibers to transmit radiation from the radiation source to the chamber, the first and second fibers arranged to individually receive radiation from the same spatial area of the radiation source." Instead, Saka is silent on the matter of optical fibers.

Thus, claim 30 and the claims dependent therefrom, including claim 36, are allowable over Giapis et al. and Piwonka-Corle, in view of Saka.

103(a) Rejection of Claims 40-51 and 57-59

The Examiner rejected claims 40-51 and 57-59 under 35 U.S.C. 103(a) as being unpatentable over Giapis et al. in view of U.S. Patent 6,299,346 to Ish-Shalom et al. (Ish-Shalom et al.) This rejection is respectfully traversed.

Claims 40 and 57

The Examiner acknowledges that "Giapis does not teach a feedback controller adapted to regulate a power level of the radiation source in relation to the detected intensity of the second radiation."

Ish-Shalom et al. fails to make up for th d fici ncies of Giapis et al. because Ish-Shalom et al. also does not teach, inter alia, "a feedback controller to regulate a power level of the radiation source <u>in relation to</u>" <u>the detected intensity</u> of the second radiation (as recited in claim 40), or alternatively <u>the reference signal</u> (as recited in claim 57).

Instead, Ish-Shalom teaches a "control system (36)" that "provides incident radiation (40) intermittently by turning radiation source (28) on and off." This is different from the "feedback controller" of claim 40 because the "control system" does not regulate the radiation source power level "in relation to" a detected intensity of a second radiation or a reference signal. The "control system" turns the radiation source on and off at a <u>predefined</u> constant rate, whereas the recited "feedback controller" regulates the power level <u>variably</u> "in relation to the intensity" measured in real-time.

Thus, claims 40 and 57, and the claims dependent therefrom, including claims 41-43, 58, and 59, are allowable over Giapis et al. in view of Ish-Shalom et al.

<u>Claim 44</u>

Claim 44 is allowable over Giapis et al. because Giapis et al. fails to teach "a radiation modulator in a path of a radiation being transmitted from the radiation source to the chamber, the radiation modulator being adapted to receive the reference signal and control a property of the radiation in relation to the reference signal." Giapis et al. is silent on the matter of a radiation modulator adapted to control a property of the radiation in relation to the reference signal.

Ish-Shalom et al. does not make up for the deficiencies of Giapis et al. because Ish-Shalom et al. also fails to teach, inter alia, "a radiation modulator ... adapted to receive the reference signal and control a property of the radiation <u>in relation to the reference signal</u>." (Emphasis added.) Instead, Ish-Shalom et al. teaches a shutter (23) to alternately allow incident radiation (40) from reaching a wafer (10) and block the incident radiation from reaching the wafer. (Col. 10, lines 50 to col. 11, line

16.) However, the shutter does not alternately allow/block th radiation "in relation to" a reference signal that corr sponds to a property of radiation from a radiation source. Instead, Ish-Shalom et al. only needs some alternating blocking of the radiation, irrespective of any particular reference signal. Thus, the shutter of Ish-Shalom et al. is not a radiation modulator adapted to "control a property of the radiation in relation to the reference signal" defined in claim 44.

Thus, claim 44 and the claims dependent therefrom, including claims 45-56, are allowable over Giapis et al. in view of Ish-Shalom et al.

103(a) Rejection of Claim 60

The Examiner rejected claim 60 under 35 U.S.C. 103(a) as being unpatentable over Giapis et al. and Ish-Shalom et al. in view of Piwonka-Corle. This rejection is respectfully traversed.

Claim 60 is allowable over Giapis et al. and Ish-Shalom et al. because it is dependent from claim 40, which is allowable over Giapis et al. and Ish-Shalom et al. for the reasons presented above.

Piwonka-Corle does not make up for the deficiencies of Giapis et al. and Ish-Shalom et al. because Piwonka-Corle is silent on the matter of "a feedback controller adapted to regulate a power level of the radiation source in relation to" the the second radiation defined in claim 40.

Thus, claim 40 and the claims dependent therefrom, including claim 60, are allowable over Giapis et al. and Ish-Shalom et al. in view of Piwonka-Corle.

CONCLUSION

The above-discussed amendments are believed to place the present application in condition for allowance. Should the Examiner have any questions regarding the above remarks, the Examiner is requested to telephone Applicant's representative at the number listed below.

Respectfully submitted,

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MARKED-UP CLAIMS FOR APPL. NO. 09/379,753

1. (thrice amended) A substrate etching apparatus comprising:

(a) a chamber comprising a substrate support to support a substrate, a gas distributor to introduce an etchant gas into the chamber, a gas energizer to energize the etchant gas, a gas exhaust to exhaust gas from the chamber, and a radiation source;

(b) one or more detectors to (i) detect an intensity of a first radiation originating from the radiation source and reflected from the substrate or a chamber wall and generate a sample signal, and (ii) detect an intensity of a second radiation emitted from the radiation source and generate a reference signal; and

(c) a signal analyzer [adapted] to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal <u>to compensate for both (i) a fluctuation in the reflected radiation that originates from the radiation source and (ii) background radiation that is not from the radiation source,</u>
[with the reference signal to generate a normalized signal, and determine]

<u>whereby</u> a thickness of a layer being etched on the substrate or chamber wall <u>is determined</u> from the normalized signal.

23. (twice am nded) A substrate etching apparatus comprising:

(a) a chamber capable of etching a substrate, the chamber comprising a substrate support to support the substrate, a gas distributor to introduce an etchant gas into the chamber, a gas energizer to energize the etchant gas, a gas exhaust to exhaust gas from the chamber, and a radiation source;

(b) a detector to detect a reflected radiation from the substrate or a chamber wall and generate a sample signal; and

(c) a signal analyzer [adapted] to receive the sample signal and determine a corrected sample signal, X_{nt}, using the expression $X_{nt} = X_t / \{Y_0 + C(Y_t - Y_0)\}$,

where C is a correction factor, Y_0 is a reference signal at time 0, X_t is the sample signal at time t, and Y_t is the reference signal at time t.

30. (twice amended) A substrate etching apparatus comprising:

(a) a chamber capable of etching a substrate, the chamber comprising a substrate support to support the substrate, a gas distributor to introduce an etchant gas into the chamber, a gas energizer to energize the etchant gas, a gas exhaust to exhaust gas from the chamber, and a radiation source;

(b) a sample detector to detect a reflected radiation from the substrate or a chamber wall and generate a sample signal;

(c) a reference detector to detect a reference radiation from the radiation source and generate a reference signal;

(d) one or more first fibers to transmit the reference radiation from the radiation source to the reference detector and one or more second fibers to transmit [the reflected] radiation from the radiation source to the chamber, the first and second fibers arranged to <u>individually</u> receive radiation from [one or more areas] <u>the same spatial area</u> of the radiation source [that have about the same size]; and

(e) a signal analyzer [adapted] to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal with the reference signal to generate a normalized signal, and determine a thickness of a layer being etched on the substrate or chamber wall from the normaliz d signal.

38. (twic amended) A substrate etching apparatus comprising:

(a) a chamber capable of etching a substrate, the chamber comprising a substrate support to support the substrate, a gas distributor to introduce an etchant gas into the chamber, a gas energizer to energize the etchant gas into a plasma, a gas exhaust to exhaust gas from the chamber, and a radiation source [that includes] other than a plasma in the chamber;

(b) a sample detector to detect a reflected radiation from the substrate or a chamber wall and generate a sample signal;

(c) a first reference detector to detect a first reference radiation from the plasma and generate a first reference signal, wherein the first reference radiation comprises a background radiation;

(d) a second reference detector to detect a second reference radiation from the radiation source and generate a second reference signal;

[one or more fibers to transmit the reference radiation to the reference detector, the fibers arranged to receive reference radiation which is not reflected from the substrate;] and

(e) a signal analyzer [adapted] to normalize the sample signal relative to the reference signal by mathematically operating on the sample signal to compensate for both (i) the background radiation from the plasma and (ii) a fluctuation in the reflected radiation, [with the reference signal to generate a normalized signal, and determine]

whereby a thickness of a layer being etched on the substrate or chamber wall is determined from the normalized signal.

40. (thrice amended) A substrate etching apparatus comprising:

(a) a chamber comprising a substrate support t support a substrate, a gas distributor to introduce an etchant gas into the chamber, a gas energizer to energize the etchant gas, a gas exhaust to exhaust gas from the chamber, and a radiation source other than a plasma in a process zone in the chamber;

(b) one or more detectors to detect an intensity of a first radiation reflected from the substrate or a chamber wall to determine a thickness of a layer on the substrate or chamber wall, and detect an intensity of a second radiation from the radiation source; and

(c) a feedback controller [adapted] to regulate a power level of the radiation source in relation to the detected intensity of the second radiation.

44. (thrice amended) A substrate etching apparatus comprising:

(a) a chamber comprising a substrate support to support a substrate, a gas distributor to introduce an etchant gas into the chamber, a gas energizer to energize the etchant gas, a gas exhaust to exhaust gas from the chamber[, and];

(b) a radiation source capable of generating a radiation;

(c) a first detector to detect a property of the radiation from the radiation source and generate a reference signal in relation to the property;

(d) a radiation modulator in a path of a radiation being transmitted from the radiation source to the chamber, the radiation modulator being adapted to receive the reference signal and control a property of the radiation in relation to the reference signal; and

(e) a second detector in a path of the radiation, the second detector capable of detecting an intensity of the radiation reflected from the substrate or a chamber wall to determine a thickness of a layer being etched on the substrate or chamber wall.

57. (twice amended) A substrate etching apparatus comprising:

a chamber comprising a substrate support to support a substrate, a gas distributor to introduce an etchant gas into the chamber, a gas energizer to energize the etchant gas, a gas exhaust to exhaust gas from the chamber, and a radiation source;

one or more detectors to detect an intensity of a radiation reflected from the substrate or a chamber wall to generate a sample signal that may be used to determine a thickness of a layer being etched on the substrate or chamber wall, and to detect a property of a radiation from the radiation source and generate a reference signal in relation to the property; and

a feedback controller [adapted] to regulate a power level of the radiation source in relation to the reference signal.

60. (once amended) An apparatus according to claim 40 wherein the one or more detectors generate a sample signal from the detected intensity of the first radiation and generate a reference signal from the detected intensity of the second radiation, and wherein the apparatus comprises a signal analyzer [adapted] to normalize the sample signal relative to the reference signal to generate a normalized signal by mathematically operating on the sample signal with the reference signal, and determine a thickness of a layer on the substrate or chamber wall from the normalized signal.